

New species and records of *Culicoides* biting midges attracted to human baits in Doi Inthanon National Park, northern Thailand (Diptera: Ceratopogonidae)

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Abstract: A total of 232 female and 1 male biting midges were caught in daytime collections using a hand net from human baits carried out from 0600 to 1800, twice a month per site at four sites (400 m, 860 m, 1,360 m and 2,460 m in altitude) in Doi Inthanon National Park, Chiang Mai, northern Thailand in 2003 and 2004. They were classified into 19 species of the genus *Culicoides* including four new species and seven known species newly recorded from Thailand. Among the newly recorded species, five were originally described from Taiwan, one from Japan, and one from Malaysia. Four new species, *C. angkaensis*, *C. choochotei*, *C. inthanonensis* and *C. tuamsombooni*, are described and figured.

Key words: *Culicoides*, biting midge, Thailand, new species

Biting midges of the genus *Culicoides* in Chiang Mai province, Thailand, were scarcely studied, as in other provinces of the country. So far, only 22 species were known (Ratanaworabhan, 1975).

Recently, we carried out collections of biting insects using a hand net from human baits from 0600 to 1800 hours at four sites [Site 1: Mae Klang Waterfall (400 m in elevation above sea level); Site 2: Tambol Ban Luang (860 m); Site 3: Siribhume Waterfall (1,360 m); Site 4: Ang Ka (2,460 m)] in Doi Inthanon National Park, Chiang Mai province. The map showing the locations of these four sites in the park refers to Choochote *et al.* (2005). Collection was carried out twice a month per each site during the period from August 2003 to July 2004. In this survey, a total of 232 female and 1 male biting midges were collected mostly in the morning (0600–0800) and in the evening (1600–

1800). They were classified into 19 species of the genus *Culicoides* including four new species and seven newly recorded species from Thailand. All the new species are herein described on the basis of the observations of female specimens.

Adult midges collected while attracted to human baits were preserved in 80% ethanol. All specimens were sorted to each group of possible different species under stereoscopic microscope according to gross morphological characters, such as body size, coloration and wing pattern. Final identification of each group and species was done after preparation of permanent slide mounts by the method of Wirth and Marston (1968). All measurements were taken using an ocular micrometer in a microscope, and expressed in millimeter. Certain wing patterns of the species were shown by photographs taken from available specimens. Geological locality names

were used for the distribution of species.

All type specimens are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

RECORDS AND DESCRIPTIONS OF SPECIES

Subgenus *Avaritia* Fox, 1955

1. *Culicoides (Avaritia) actoni* Smith

Culicoides actoni Smith, 1929, Indian J. Med. Res. 16: 255 (female; Assam).

Culicoides okumensis Arnaud, 1956, Microentomology 21: 119, female, Okinawa.

Culicoides actoni, 1956, Ratanaworabhan, Chiang Mai.

Culicoides actoni, 1998, Lien *et al.*, Taiwan.

Distribution. Australia, India, Indonesia, Japan, Kampuchea, Laos, Malaysia, New Guinea, Philippines, Sabah, Sri Lanka, Taiwan and Thailand.

Specimens examined. 1 male, 14 females (Site 2).

Dates of collections. 10.X.2003 (2 females), 7.III.2004 (1 female, 1 male), 8.V.2004 (2 females), 10.V.2004 (5 females), 14.VI.2004 (2 females), 15. VI. 2004 (1 female), 12.VII.2004 (1 female).

2. *Culicoides (Avaritia) albifascia* Tokunaga

(Fig. 1)

Culicoides albifascia Tokunaga, 1957, Tenthredo 1: 319 (female; Taiwan).

Culicoides albifascia, 1998, Lien *et al.*, female, Taiwan.

Culicoides albifascia, 1978, Lee, Tibet.

Distribution. Taiwan, Thailand (new record) and Tibet.

Specimens examined. 5 females (Site 3), 7 females (Site 4).

Dates of collections. Site 3: 17.VIII.2003 (1 female), 18.VIII.2003 (1 female), 27.IX.2003 (1 female), 19.X.2003 (1 female), 19. XII.2003 (1 female); Site 4: 31.VIII.2003 (1 female), 19.IX.2003 (3 females), 21.IX.2003 (1 female), 26.VI.2004 (1 female), 25.VII.

2004 (1 female).

3. *Culicoides (Avaritia) brevipalpis* Delfinado

Culicoides brevipalpis Delfinado, 1961, Fieldiana; Zool. 33: 654, (female; Philippines).

Culicoides brevipalpis, 1975, Ratanaworabhan, Chiang Mai.

Culicoides brevipalpis, 1998, Lien *et al.*, Taiwan.

Distribution. Australia, Indonesia, Laos, Malaysia, Japan (Okinawa), Philippines, Sri-Lanka, Taiwan and Thailand.

Specimens examined. 4 females (Site 3).

Dates of collections. 18.VIII.2003 (2 females), 27.IX.2003 (1 female), 21.VII.2004 (1 female).

4. *Culicoides (Avaritia) jacobsoni* Macfie

Culicoides jacobsoni Macfie, 1934, Tijdschr. Entomol. 77: 215 (male; Sumatra).

Culicoides kitaokai Tokunaga, 1955, females; Tokyo.

Distribution. China, Indonesia, Japan, New Guinea, Peninsular Malaysia, Philippines, Taiwan and Thailand.

Specimens examined. 1 female (Site 1), 65 females (Site 2), 10 females (Site 3).

Dates of collections. Site 1: 22.IX.2003 (1 female); Site 2: 10.VIII.2003 (56 females), 4.IX.2003 (4 females), 7.IX.2003 (4 females), 11.X.2003 (1 female); Site 3: 18. VIII.2003 (2 females), 27.IX.2003 (3 females), 28.IX.2003 (3 females), 21.X.2003 (2 females).

5. *Culicoides (Avaritia) maculatus* (Shiraki)

Ceratopogon maculatus Shiraki, 1913, Taiwan Sotokufu Noji Shikenjo Tokubetsu Hokoku 1: 294 (male, female; Taiwan).

Culicoides sigaensis Tokunaga, 1937, Japan.

Culicoides sigaensis, 1975, Ratanaworabhan, Thailand.

Culicoides maculatus, 1998, Lien *et al.*,

Taiwan.

Distribution. China, Indonesia, Japan, Laos, Malaysia, Pakistan, Philippines, Taiwan, Thailand and Vietnam.

Specimen examined. 1 female (Site 2).

Date of collection. 10.VIII.2003 (1 female).

6. *Culicoides (Avaritia) orientalis* Macfie

Culicoides orientalis Macfie, 1932, Ann. Mag. Nat. Hist. 10: 490 (male, female; India).

Culicoides orientalis, 1975, Ratanaworabhan, Thailand.

Culicoides orientalis, 1998, Lien *et al.*, Taiwan.

Culicoides orientalis, 2005, Kitaoka, Kyushu.

Distribution. India, Indonesia, Japan (Kyushu), Laos, Malaysia, New Guinea, Philippines, Taiwan and Thailand.

Specimens examined. 3 females (Site 2), 1 female (Site 3).

Dates of collections. Site 2: 10.VIII.2003 (1 female), 16.VIII.2003 (1 female), 18.I.2004 (1 female); Site 3: 27.IX.2003 (1 female).

7. *Culicoides (Avaritia) trimaculatus* McDonald and Lu

(Fig. 2)

Culicoides trimaculatus McDonald and Lu, 1972, J. Med. Entomol. 5: 415 (female; Taiwan).

Culicoides trimaculatus, 1998, Lien *et al.*, Taiwan.

Distribution. Taiwan and Thailand (new record).

Specimens examined. 2 females (Site 2), 1 female (Site 3).

Dates of collections. Site 2: 7.IX.2003 (1 female), 15.VI.2004 (1 female); Site 3: 27.IX.2003 (1 female).

Subgenus *Culicoides* s. str.

8. *Culicoides (Culicoides) angkaensis* Kitaoka, Takaoka and Choochote, sp. nov.

(Figs. 3 and 11)

Female. Wing length 1.34 mm (1.18–1.50 mm, n=6).

Head: Eyes contiguous, bare. Antenna with length of segments in proportion of 36:24:28:28:28:28:28:34:34:36:36:54, AR 1.18; sensilla coeloconica present on segments 3, 11–15. Palpus (Fig. 11) with lengths in proportion of 25:110:100:50:50; third palpal segment slightly swollen proximally, with round, shallow sensory pit at distal third; PR 2.9. Proboscis moderately long, P/H ratio 0.87; mandible with about 22 teeth.

Thorax: Dark brown, without conspicuous pattern. Legs dark brown, all femora dark to tip; all tibiae pale basally; hind tibial comb with 5 spines, second from spur longest.

Wing (Fig. 3): Pattern as figured, CR 0.69. Haltere pale.

Abdomen: Dark brown. Spermathecae ovoid with short necks, slightly unequal, 0.125 by 0.065 and 0.095 by 0.058.

Male. Unknown.

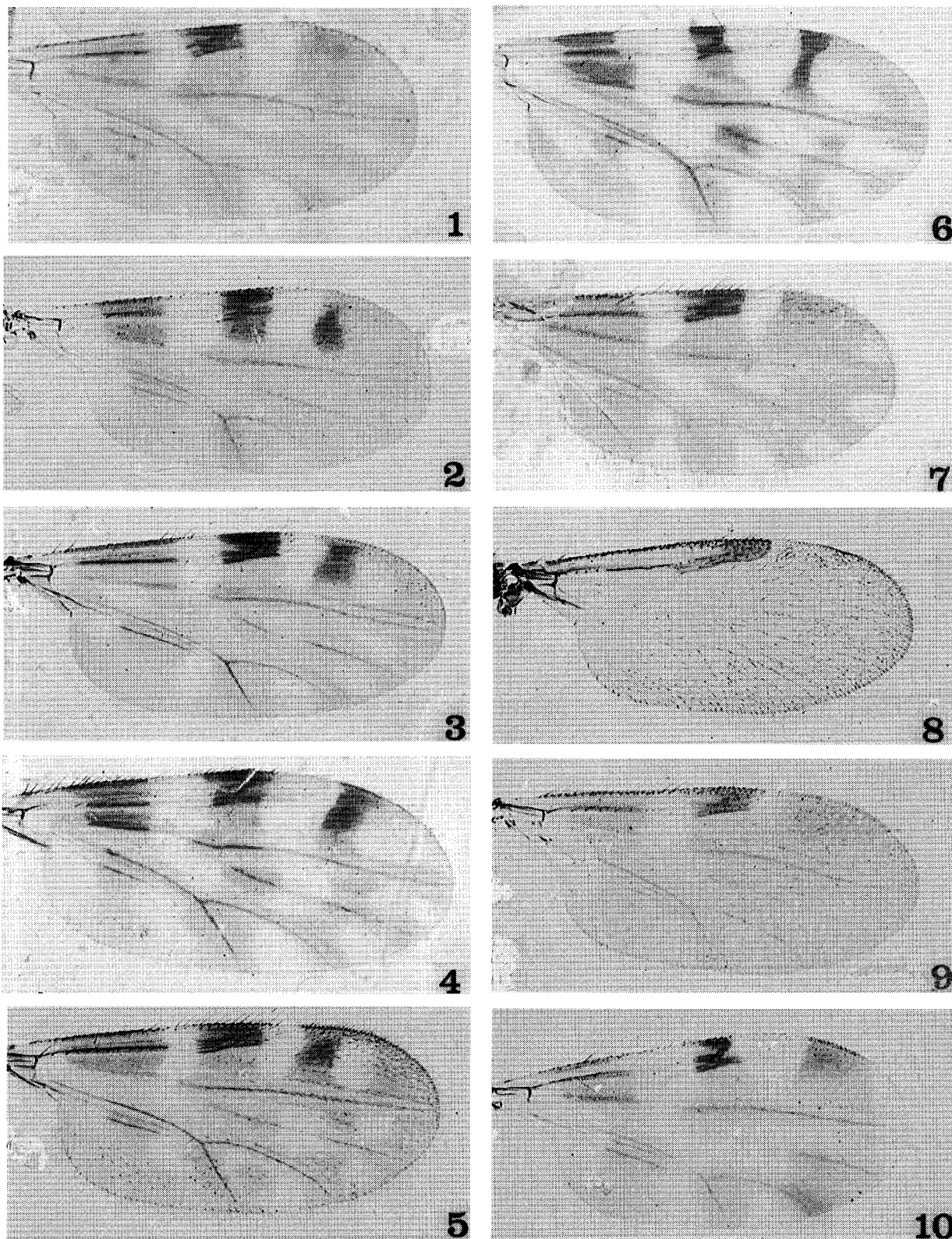
Types. Holotype female, Ang ka (Site 4), Doi Inthanon National Park, 18.IX.2003 by W. Choochote; paratypes: 5 females, same data as those of holotype.

Other specimens examined. 4 females (Site 3), 11 females (Site 4).

Dates of collections. Site 3: 18.VIII.2003 (2 females), 19.XI.2003 (1 female), 19.XII.2003 (1 female); Site 4: 18.IX.2003 (8 females), 21.IX.2003 (1 female), 23.X.2003 (1 female), 25.X.2003 (1 female).

Etymology. The species name *angkaensis* refers to the name of the locality, Ang Ka, at the top of the Doi Inthanon National Park, where this new species was collected.

Remarks. *Culicoides angkaensis* sp. nov. resembles *C. kinabalensis*, which was recorded from Mt. Kinabalu, the highest mountain in Borneo (Wirth and Hubert, 1989), in that both species have similar wing pattern and certain numerical char-



Figs. 1-10. Wings of females of *Culicoides* species. 1, *C. albifascia*; 2, *C. trimaculatus*; 3, *C. angkaensis* sp. nov.; 4, *C. choochotei* sp. nov.; 5, *C. mcdonaldi*; 6, *C. tienhsiangensis*; 7, *C. inthanonensis* sp. nov.; 8, *C. nunomemoguri*; 9, *C. tuamsombooni* sp. nov.; 10, *C. flavitibialis*.

acters, but the latter species differs by its vestigial mandibular teeth and third palpal segment with round to irregular sensory pit.

9. *Culicoides (Culicoides) choochotei* Kitaoka and Takaoka, sp. nov.

(Figs. 4 and 12)

Female. Wing length 1.62 mm.

Head: Eyes contiguous for a short distance, bare. Antenna with lengths of flagellar segments in proportion of 40:32:36:36:32:32:32:32:50:50:60:70:100, AR 1.21, sensilla coeloconica present on segments 3, 11–15. Palpus (Fig. 12) with lengths of segments in proportion of 43:100:114:46:46. PR 5.0; second segment moderately stout, third segment slender, widest at middle, sensilla scattered over distal half of segment, PR 5.6. Proboscis long, P/H ratio 1.00; mandible with about 17 small teeth.

Thorax: Dark brown, without distinct pattern. Legs dark, all femora paler distally and all tibiae pale basally; hind tibial comb with 6 spines, second from spur longest.

Wing (Fig. 4): Pattern as figured. Wing dark brownish with pale markings small and faint. Macrotrichia very scanty on distal fourth of wing, CR 0.68. Haltere pale.

Abdomen: Dark brown. Spermathecae sub-spherical, tapering to short necks; slightly unequal, 0.092 by 0.060 and 0.082 by 0.060.

Male. Unknown.

Type. Holotype female, Ang Ka (Site 4), Doi Inthanon National Park, 18.IX.2003, by W. Choochote.

Etymology. The species name *choochotei* is in honor of Mr. W. Choochote, Associate Professor, Department of Parasitology, Chiang Mai University, for his enthusiasm and great contribution to the study of haemophagous insects, such as mosquitoes, simuliids and biting midges in Thailand.

Remarks. *Culicoides choochotei* sp. nov. resembles *C. brinchangensis*, of which the type specimens were recorded from Mt. Brinchang, 1,600 m, Peninsular Malaysia (Wirth and Hubert, 1989), but the latter species is distinguished by its third palpal segment stout (PR 3.2) with round, shallow

sensory pit.

10. *Culicoides (Culicoides) mcdonaldi* Wirth and Hubert

(Fig. 5)

Culicoides pulicaris monticolus McDonald and Lu, 1972, J. Med. Entomol. 9: 413 (female; Taiwan).

Culicoides monticolus McDonald and Lu, 1998, Lien *et al.*, Taiwan.

(*Culicoides monticolus* was preoccupied by *C. monticola* Wirth and Lee, 1967, from Colombia. The new name *C. mcdonaldi* Wirth and Hubert, 1989 was proposed later).

Distribution. Taiwan and Thailand (new record).

Specimen examined. 6 females (Site 2), 15 females (Site 3).

Dates of collections. Site 2: 6.III.2004 (6 females); Site 3: 27.IX.2003 (4 females), 28.IX.2003 (1 female), 18.X.2003 (1 female), 21.X.2003 (1 female), 19.XII.2003 (2 females), 24.I.2004 (2 females), 14.II.2004 (2 females), 15.V.2004 (1 female), 21.VII.2004 (1 female).

11. *Culicoides (Culicoides) tienhsiangensis* Chen

(Fig. 6)

Culicoides tienhsiangensis Chen, 1988, Chin. J. Entomol. 8: 153 (female; Taiwan).

Culicoides tienhsiangensis, 1988, Lien *et al.*, female and male, Taiwan.

Distribution. Taiwan and Thailand (new record).

Specimens examined. 59 females (Site 4), 3 females (Site 3).

Dates of collections. Site 3: 27.IX.2003 (2 females), 24.I.2004 (1 female); Site 4: 18.IX.2003 (13 females), 21.IX.2003 (32 females), 25.X.2003 (2 females), 27.XII.2003 (1 female), 21.V.2004 (1 female), 23.V.2004 (4 females), 25.VII.2004 (2 females), 27.VII.2004 (4 females).

Remarks. This large yellowish species is the most predominant of the four species collected at Ang Ka (2,460 m above

sea level) and was collected from May to January.

Subgenus *Oecacta* Poey, 1853

12. *Culicoides (Oecacta) inthanonensis*
Kitaoka, Takaoka and Choochote,
sp. nov.

(Figs. 7 and 13)

Female. Wing length 0.96 mm.

Head: Eyes bare, separated about 1 facet. Antennal segments in proportion of 36:26:26:28:30:28:28:28:40:42:46:42:74, AR 1.05, sensilla coeloconica on segments 3, 13–15. Palpus (Fig. 13) with lengths in proportion of 30:75:73:25:38, PR 3.0, third segment slightly swollen in proximal part, with round shallow sensory pit. Proboscis short, P/H ratio 0.65, mandible with about 16 teeth.

Thorax: Brown, mesonotum with pattern of a pair of large pale area. Legs brown, fore and

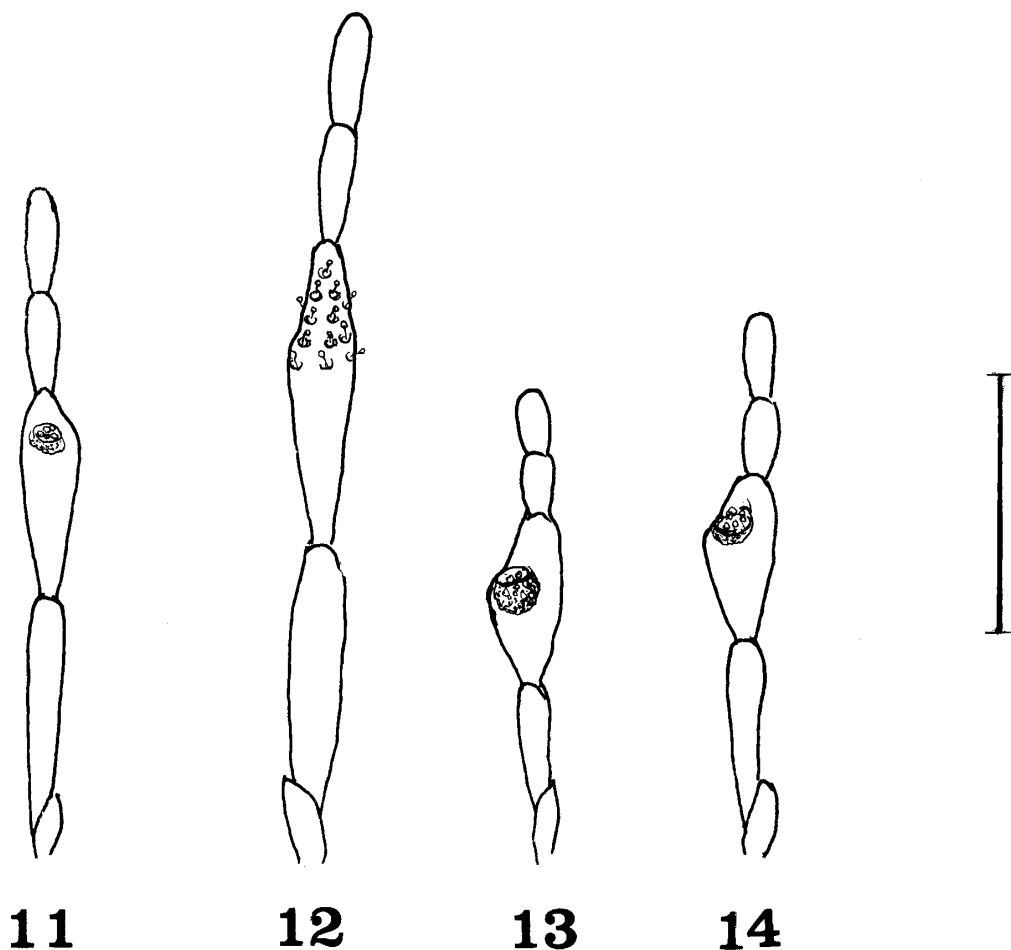
mid femora with subapical pale rings, all tibiae with subbasal narrow pale rings, hind tibial comb with 4 spines, the one nearest to spur longest.

Wing (Fig. 7): Pattern as figured, with indistinct pale spot; pale spot over r-m crossvein; poststigmatal pale spot in cell R5 small, proximal half covering distal half of second radial cell, cells R5, M1, M2 with indistinct oval pale spot in proximal portion of cell M4 with a moderately large, rounded, pale spot in distal half of cell, anal cell with a small pale spot in anterobasal corner. Macrotrichia sparse, CR 0.62. Haltere infuscated.

Abdomen: Brown. Spermathecae subspherical, with long, slender necks; 0.075 by 0.055 and 0.070 by 0.050.

Male. Unknown.

Type. Holotype female, Tambol Ban Luang (Site 2), Doi Inthanon National Park, 15.VI.2004, by W. Choochote.



Figs. 11–14. Palpi of females of four new species of *Culicoides*. 11, *C. angkaensis* sp. nov.; 12, *C. choochotei* sp. nov.; 13, *C. inthanonensis* sp. nov.; 14, *C. tuamsombooni* sp. nov.
Scale. 0.1 mm.

Other specimen examined. 1 female, same data as in holotype.

Etymology. The species name *inthanonensis* refers to the name of the national park, where this new species was collected.

Remarks. *Culicoides inthanonensis* sp. nov. is similar to *C. geminus* Macfie, 1937 in the *shermani* group (Wirth *et al.*, 1985), but the latter species is distinguished by its sensilla coeloconica on antennal segments 3 and 11–14, and with the sensilla bore in a shallow irregular sensory area. Also, the new species superficially resembles *C. siamensis* (the holotype female collected from Doi Sutep, Chiang Mai) (Wirth and Hubert, 1989), but the latter species is easily distinguished by its larger body size (1.28 mm) and broadly swollen palpus (PR 1.7).

13. *Culicoides (Oecacta) nunomemoguri* Kitaoka

(Fig. 8)

Culicoides (Oecacta) nunomemoguri Kitaoka, 1980, Natl. Inst. Anim. Hlth Q., 20: (female, Niigata).

Female. Wing length 0.98 mm.

Head: Eyes widely separated for about 3 facets, with intrafacetal hairs of length of about 0.05. Antenna with lengths of flagellar segments in proportion of 24:18:18:18:18:18:18:26:26:26:26:50, AR 0.99. Palpus with lengths in proportion of 30:75:73:25:38; third segment moderately swollen distally, with a large shallow round, or irregular sensory pit, PR 3.0. Proboscis moderately long, P/H ratio 0.86, mandible with about 18 teeth. Cibarial armature of small papillae on the epipharyngeal wall.

Thorax: Dark brown, mesonotum without apparent pattern. Legs dark brown, without pale markings; hind tibial comb with 4 spines, the second longest.

Wing (Fig. 8): Pattern as figured, deeply infuscated of second radial cell and of veins bordering second radial cell. Macrotrichia relatively sparse, but strong. CR 0.60. Haltere infuscated.

Abdomen: Brown. Spermathecae oval, without necks, subequal, 0.068 by 0.050 and 0.060

by 0.048.

Distribution. Japan and Thailand (new record).

Specimens examined. 2 females (Site 4).

Date of collection. 21.IX.2003 (2 females).

Remarks. *Culicoides nunomemoguri*, originally described from Niigata, Japan (Kitaoka, 1980), belongs to the *cosmosiocalatus* (= *chaetophthalmus*) group which is rich in species in the Palaearctic Region. This is the second species of the *cosmosiocalatus* group recorded in Southeast Asia, where this group was so far represented by only one species, *C. majorinus* Chu, 1977, of which the type specimen was collected from Tibet (Wirth *et al.*, 1985). From the result of morphological comparison among the present Thai and Japanese specimens [the latter, Honshu (Niigata, Iwate, and Aomori) and Hokkaido (Hidaka and Tokachi)], slight differences found in certain characters were considered to be intraspecific variation.

Adult females of *C. nunomemoguri* feed actively on the skin of farmers in rice fields at Horinouchi-machi in Niigata (type locality). Considerable numbers of adult females were easily collected from human baits, and then, they were served for the material of laboratory colonization by the method of Morii and Kitaoka (1968). In the laboratory, the females lay only infertile eggs though they are easily blood-fed (Kitaoka, unpublished data).

14. *Culicoides (Oecacta) oxystoma* Kieffer

Culicoides oxystoma Kieffer, 1910; Mem. Ind. Mus. 2: 193 (female; India).

Culicoides schulzei, (misidentified), 1978, Ratanaworabhan, Chiang Mai.

Distribution. Southern Asia from Turkey to Afghanistan, east to Pakistan, northern Australia, India, Indonesia, Japan, Philippines, Taiwan and Thailand.

Specimen examined. 1 female (Site 3).

Date of collection. 21.X.2003 (1 female)

15. *Culicoides (Oecacta) shortti* Smith and Swaminath

Culicoides shortti Smith and Swaminath, 1932; Mem. Ind. Mus. Res. 2: 193 (female; Assam).

Culicoides shortti, 1975, Ratanaworabhan, female, Chiang Mai.

Distribution. India, Indonesia, Kampuchea, Laos, Malaysia, Taiwan, Thailand and Vietnam.

Specimens examined. 9 females (Site 2).

Dates of collections. 10.VIII.2003 (1 female), 6.II.2004 (1 female), 8.II.2004 (3 females), 6.III.2004 (2 females), 7.III.2004 (1 female), 15.V.2004 (1 female).

16. *Culicoides (Oecacta) tuamsombooni* Kitaoka, Takaoka and Choochote, sp. nov.

(Figs. 9 and 14)

Female. Wing length 0.93 mm (0.73–1.10 mm, n=10).

Head: Eyes bare, widely separated for about 2 facets. Antenna with flagellar segments in proportion of 26:20:20:20:22:22:20:22:32:30:32:30:46, AR 0.99; sensilla coeloconica on segments 3, 11–15. Palpus (Fig. 14) with lengths of segments in proportion of 24:50:60:24:26; third segment with deep sensory pit, PR 2.0. Proboscis short, P/H ratio 0.66, mandible with about 18 teeth.

Thorax: Brown, legs brown, tibiae paler basally, hind tibial comb with 4 spines, second the largest. Wing (Fig. 9): Present very faint pattern of pale spots; a pale spot over r-m crossvein, poststigmatic pale spot small. Macrotrichia sparse at basal portion of wing. CR 0.58. Haltere pale.

Abdomen: Spermathecae ovoid and tapering to moderate necks; subequal 0.062 by 0.042 and 0.060 by 0.044.

Male. Unknown.

Type. Holotype female, Siribhume Waterfall (Site 3), Doi Inthanon National Park, 15.II.2004, by W. Choochote. Paratypes: 8 females, same data as those of holotype, and 1 female, same data as those of holotype except date, 14.II.2004.

Etymology. The species name *tuamsom-*

booni is in honor of Mr. Surachai Tuamsomboon, Chief, Headquarters of Doi Inthanon National Park.

Remarks. The wing pattern of *C. tuamsombooni* sp. nov. is similar to that of *C. wenzeli* Delfinado, 1961, a member of the *shermani* group (Wirth et al., 1985). They are common in having only 2 pale spots on the wing, but the latter has a deep sensory pit on the third palpal segment and sensilla coeloconica on all antennal segments 3–15.

Subgenus *Trithecodes* Wirth and Hubert

17. *Culicoides (Trithecodes) elbeli* Wirth and Hubert, 1959

Culicoides elbeli Wirth and Hubert, 1959, Mem. Amer. Entomol. Inst. No. 44: 27 (male, female; Malaysia, Sabah, Thailand).

Culicoides elbeli, 1985, Howarth, Laos.

Distribution. Indonesia, Laos, Malaysia, Sabah, Sarawak and Thailand.

Specimens examined. 65 females (Site 2).

Dates of collections. 10.VIII.2003 (21 females), 4.IX.2003 (17 females), 7.IX.2003 (5 females), 6.III.2004 (6 females), 12.VII.2004 (2 females), 14.VII.2004 (14 females).

18. *Culicoides (Trithecodes) flavitibialis* Kitaoka and Tanaka

(Fig. 10)

Culicoides flavitibialis Kitaoka and Tanaka, 1985, Jpn. J. Sanit. Zool. 36: 42 (female; Taiwan).

Distribution. Taiwan and Thailand (new record).

Specimens examined. 4 females (Site 2).

Dates of collections. 10.VIII.2003 (1 female), 4.IX.2003 (1 female), 7.IX.2003 (1 female), 14.VII.2004 (1 female).

19. *Culicoides (Trithecodes) subpalpifer* Wirth and Hubert

Culicoides subpalpifer Wirth and Hubert, 1959, Mem. Amer. Entomol. Inst. No. 44: 115 (female; Malaysia).

Distribution. Malaysia, Philippines, Sabah, Sarawak, Thailand (new record).

Specimens examined. 9 females (Site 2).

Dates of collections. 4.IX.2003 (2 females), 8.V.2004 (1 female), 15.VI.2004 (3 females), 14.VII.2004 (3 females).

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